

## **Summary of LOX/CH<sub>4</sub> Thruster Technology Development at NASA/MSFC**

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In recent years, a variety of injectors for liquid oxygen (LOX) and methane (CH<sub>4</sub>) propellant systems have been designed, fabricated, and demonstrated with hot-fire testing at Marshall Space Flight Center (MSFC). Successful designs for liquid methane (LCH<sub>4</sub>) and gaseous methane (GCH<sub>4</sub>) have been developed. A variety of chambers, including a transpiration cooled design, along with uncooled ablatives and refractory metals, have also been hot-fire tested by MSFC for use with LOX/LCH<sub>4</sub> injectors. Hot-fire testing has also demonstrated multiple ignition source options. Heat flux data for selected injectors has been gathered by testing with a calorimeter chamber. High performance and stable combustion have been demonstrated, along with designs for thrust levels ranging from 500 to 7,000 lbf. The newest LOX/CH<sub>4</sub> injector and chamber developed by MSFC have been fabricated with additive manufacturing techniques and include unique design features to investigate regenerative cooling with methane. This low cost and versatile hardware offers a design for 4,000 lbf thrust and will be hot-fire tested at MSFC in 2015. Its design and operation can easily be scaled for use in systems with thrust levels up to 25,000 lbf.

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